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SAFETY IN RAILWAY TRAVEL.

WE have at present in the United States, in round numbers, one hundred thousand miles of railroads completed and in operation, employing not less than half a million persons, and transporting annually about three hundred and seventy-five millions of passengers. Upon this great system of roads there occurs upon an average each year one thousand more or less serious disasters to trains in motion, either from collision, derailment, or failure of roadway bridges or rolling-stock, by which two hundred and fifty persons are killed, and a thousand more receive injuries more or less severe. But the number of persons killed and injured by accidents affecting directly the trains in motion does not amount to over twelve per cent. of the whole list of killed and wounded which is chargeable, directly or indirectly, to the railroad system. As far as we can obtain information from the exceedingly incomplete returns in this country, the whole number of persons killed and injured each year is not less than ten thousand. Of this number only about one-half are connected with the railroads, either as passengers or employés; the other half being injured at railroad crossings, or by walking upon the track, or about station grounds, one-third of the whole number injured being returned as "trespassers." Of the whole number who, if the expression may be used, are injured legitimately, *i. e.*, passengers and employés, one-third are passengers and two-thirds are employés. Of the whole number of passengers suffering from accidents, something less than one-half are injured from causes for which the railroad companies are more or less responsible, while something more than one-half are injured by accidents for which the passengers themselves are alone accountable. Of the whole number of accidents to individuals, a little less than one-half are fatal; of accidents to employés about

forty per cent. are fatal; while about twenty-five per cent. of the casualties to passengers are attended with loss of life. Of the whole number of persons injured in a year, therefore, less than ten per cent. are passengers for whose injuries the companies can be held to blame; and of the whole number killed not over five per cent. are passengers for whose deaths the companies can be considered accountable.

To see how immeasurably superior the railroad is in point of safety to all other modes of transportation, we have only to compare the number of casualties with the number of persons transported. It will, of course, be understood that all such comparisons are of the roughest kind, especially in this country, where no system exists for collecting or preserving any uniform data in regard to railroad operation. Of the 375,000,000 persons annually carried over the railroads of the United States, about 1800 meet with injuries more or less severe, while 460 are killed. Of the above numbers, 800 of those injured and 200 of the killed may be charged to causes for which the railroad companies are to a greater or less degree responsible, while the rest of the casualties are due to the carelessness of the passengers themselves. For every railroad passenger, therefore, who is killed in the United States, over 800,000 are carried safely; while for every passenger for whose death the railroad companies are accountable, nearly 2,000,000 are safely transported. For every railroad passenger who is in any way injured, 200,000 are safely carried; while for every passenger injured by causes for which the companies are responsible, nearly 500,000 are transported without accident. In Massachusetts—where the records have been more carefully and more systematically kept for the past ten years than in any other part of the country—the number of passengers carried in that time was, in round numbers, 400,000,000; of which number 581 were injured, 132 of them fatally. Of the whole number 250 were injured from causes beyond their own control, the remainder suffering from their own lack of care. Thus, for every passenger in any way injured, 688,000 were safely carried, while for every passenger killed 3,000,000 in round numbers were transported without injury. If we consider only those who were killed or injured from causes over which they themselves had no control, the results are somewhat different. Thus, in Massachusetts, during the nine years from 1871 to 1879, the number of

passengers carried was 303,000,000, of which number 51 were killed by causes beyond their own control. For every person killed, therefore, 6,000,000 were safely carried. As the average distance traveled by each person was about 15 miles, the total distance traveled by all before death happened to any one was 90,000,000 miles. In other words, a passenger with average good luck would travel at the rate of 60 miles an hour for 10 hours a day, for 300 days in a year, for 500 years, or he would go 3600 times around the earth, before getting killed.

It has been stated on good authority that there were actually more persons killed and injured each year in Massachusetts fifty years ago, through accidents to stage-coaches, than there are now through accidents to railroad trains, notwithstanding the enormous increase in the number of persons transported. From the statistics of over forty years, in France, it appears that, in proportion to the whole number carried, the accidents to passengers by stage-coaches in old times were, as compared to those by railroads, as about sixty to one. The official returns in France actually show that a man is safer in a railroad train than he is in his own house; while in England the figures show that hanging is thirty times more likely to happen to a man than death by railroad. It is stated by Mr. Adams, in his "Notes on Railroad Accidents," that the annual average of deaths by accident in the city of Boston alone exceeds that consequent on running all the railroads of the State of Massachusetts by eighty per cent., and that, in the five years from 1874 to 1878, more persons were murdered in Boston than lost their lives on all the railroads of the State for the nine years from 1871 to 1878, though those years included both the Revere and the Wollaston disasters, or fifty deaths. Such facts go far to prove the statement made thirty years ago by Dr. Lardner, that "of all means of locomotion which human invention has yet devised, railway traveling is the safest in an almost infinite degree"; and the equally forcible statement of Mr. Adams, that "it is not the dangers, but the safety of the modern railroad which should excite our special wonder."

True as the above certainly is, it is still the fact that hundreds of persons are killed and wounded by terrible catastrophes upon our railroads every year, and that trains crash into each other and plunge through bridges, while whole car-loads of passengers are crushed and mangled, drowned, and burned to death.

It is equally the fact that by far the greater part of these disasters can be prevented, if we care to do it. By far the larger portion of the so-called accidents are not accidents at all, but are the natural and inevitable result of laws perfectly well understood. Safe as railroad travel already is, it is not safe enough if it can be made safer. That it can be made safer admits of no question. To understand the various causes of disaster is the first step to be taken.

The various so-called railroad accidents may be divided into four classes. First, injuries to persons in no way properly connected with the railroads, either as passengers or employés; second, injuries to the hands employed on the trains or about the roads; third, to passengers who suffer from their own want of care; and, fourth, to passengers who are injured by causes for which the companies are plainly accountable. The proportion between these several classes in Massachusetts, for the ten years from 1872 to 1881, was:

Whole number of persons injured	3095
Not directly connected with the roads	1415
The companies' employés.....	1108
Passengers injured through their own carelessness	322
Passengers injured by causes beyond their own control	250

Looking in detail at the first class, which makes a little over forty-five per cent. of the whole, we find that of the 1415 injured 1043 are returned as "trespassers," while the remaining 372 were injured at highway crossings and at stations. A little over one-third of all the casualties in Massachusetts are due to persons improperly walking, playing, or lying drunk upon railroad tracks; persons for whose injury the railroad companies are not in the slightest degree to blame. Indeed, the companies take every possible precaution to warn people away from their tracks, while the State adds its authority by the enactment of laws against this sort of trespass. But the free-born American citizen seems to regard it as one of his privileges to be killed upon railroad tracks, and resists any attempt, either on the part of the railroad company or the State, to interfere with his rights. Indeed, a few arrests, which were at one time made, of trespassers upon railroad tracks, were promptly followed by obstructions placed on the track by the aggrieved parties. There seems, therefore, but one thing to be done in regard to this most fruitful of all causes of injury, viz.: to warn the

public plainly, thus throwing the whole blame upon the victims. This the companies already do. It might be practicable to patrol the track in certain places, as is already done in the case of some bridges ; but this remedy would be of only limited application.

With regard to the 370 persons injured at highway crossings and at stations, these cases, too, are in nearly every instance chargeable to the victims themselves, as town and city crossings are carefully guarded, while at the country roads suitable warning is always provided. It is, perhaps, a peculiarity of American railroads that the highway crossings are generally at grade, even in the midst of the larger towns and cities ; and at a very large number of these crossings the trains pass at high speed. It might be supposed that the public would insist upon overhead crossings at such places, as the expense of such would fall upon the companies ; but the reverse is almost always the case. The public prefers the risk of accident to the inconvenience of the grade in the highway.

To pass to our second division, injuries to employés, we find the following causes recorded during the ten years from 1872 to 1881, in Massachusetts : Coupling cars, 322 ; overhead bridges, 99 ; train accidents, 128 ; falling from trains, 159 ; locomotive explosions, 14 ; other causes, 287. Of the accidents to employés, therefore, at least two-thirds are due to the carelessness of the persons injured ; and when we notice the reckless manner in which the hands employed about the stations in making up trains expose themselves, the only wonder is that the number injured is so small. The large proportion of casualties chargeable to coupling cars would seem to point to the desirability of a good self-coupling device, or at any rate to a coupling which would not require the train-hands to stand between the cars. With regard to overhead bridges, while it might perhaps be feasible to require all new structures to have a height sufficient to allow the brakeman to pass under them while standing on top of the car, it would hardly be practicable to require this of the large number of the older bridges. In such cases the ordinary guard on each side of the bridge, arranged to warn the brakeman in season, should be provided, and, what is not less essential, should be kept in good order.

We come next to injuries to passengers, and we find at the outset that more than half of all such casualties arise from lack of caution in the passengers themselves ; and in almost every

case this lack of caution consists in getting on or off the cars, or in passing from one car to another when the train is in motion. This is done in spite of the warning given by the companies. Indeed, as a general rule, when the officials have endeavored forcibly to remove passengers from this source of danger, the latter have felt themselves very much aggrieved. Many of the regulations upon European roads seem to assume that the traveler has something less than average common sense, and would certainly not be tolerated in this country. The ordinary traveler in the United States "reckons" that he is big enough to look out for himself, and as a general thing he certainly is, and he would be pretty sure to object to a rule which should prevent his passing from his seat in the Pullman to the smoking-car while the train was in motion. Tell him, if you like, that by so doing he runs one chance in a million of being killed, and quite likely he would reply that he would take that chance; and there may be no objection to his doing so, having it, of course, understood that he alone is responsible in case of injury.

To come to our last division, viz., passengers killed or injured by causes for which the companies are more or less to blame, we find that, in a total throughout the United States for the nine years from 1873 to 1881 inclusive, of 9523 accidents, 2980 were from collisions, 1169 from defects of roadway and bridges, 673 from defects of rolling-stock, 844 from negligence in operation, and 1287 from various unforeseen occurrences, while 2031 were unexplained. It is worthy of notice that of the above total of 9523 accidents about 6000, or nearly two-thirds of the whole number, were unattended by either death or injury; while less than one-sixth were productive of death. Looking a little more in detail, we find the following facts in regard to collisions. We divide these catastrophes into three classes, the first being where one train runs into the rear of another, the second where the trains come together head to head, and the third where trains meet at railway crossings. The number of collisions for nine years throughout the country has been as follows:

<i>Year.</i>	<i>Rear.</i>	<i>Head.</i>	<i>Crossing.</i>	<i>Year.</i>	<i>Rear.</i>	<i>Head.</i>	<i>Crossing.</i>
1873....	187	.. 102	.. 31	1878....	142	.. 70	.. 7
1874....	131	.. 87	.. 19	1879....	206	.. 86	.. 17
1875....	141	.. 104	.. 18	1880....	274	.. 141	.. 22
1876....	159	.. 94	.. 15	1881....	366	.. 146	.. 24
1877....	159	.. 96	.. 13				

Of various other causes, we find the following :

<i>Year.</i>	<i>Defects of Road.</i>	<i>Defects of Machinery.</i>	<i>Neglect in Operation.</i>	<i>Unforeseen Accidents.</i>	<i>Unexplained Accidents.</i>
1873.....	167	73	101	152	315
1874.....	129	63	93	141	218
1875.....	206	100	100	207	222
1876.....	125	76	108	160	185
1877.....	118	66	85	131	177
1878.....	72	41	65	125	175
1879.....	94	66	90	113	192
1880.....	89	64	98	108	237
1881.....	169	124	104	150	310

The length of time covered by the above tables is too short, and the general character of railroad statistics in this country too unreliable, to admit of drawing any very general conclusions from these figures. We cannot, however, help noticing the very decided increase in the number of accidents in 1881—an increase which cannot be accounted for by the new roads brought into operation during that year. The number of collisions during the past three years shows an increase much greater than the length of new roads or the augmented amount of traffic would seem to warrant. This is in accordance with the general principle that the danger of collision increases as the square of the number of trains; if we double the number of trains, we quadruple the chance of collision. This form of accident is always sure to follow any considerable increase in the volume of traffic, and the only remedy is to be found in more precise methods of moving trains. A system like the old schedule plan for running a few trains upon a single track road, will do for a while, and, under careful management and good luck, will allow of a certain amount of growth in the traffic; but there comes a time when the number of trains demands, not an extension of an old system, but a new and a different one. Railroad trains have entered and left the Cannon Street Station in London at the rate of over one a minute for eighteen successive hours. Such work could never be done by the mode in use at American stations, where a few men run about from switch to switch; but it is made perfectly easy and safe by the interlocking system of switches used in England. The rapidly increasing number of collisions would seem to show that the present system of controlling the movement of trains is becoming outgrown. Just as soon as this fact is fully recognized, we may be sure that American ingenuity will

supply what is needed in the shape of an improved method. None are so vitally interested in this matter as the railway companies, and very few serious disasters can occur without producing the necessary change.

Closely connected with the subject of collisions are two very important points. Many of the worst disasters of this kind would have been prevented altogether, and others rendered much less fatal, had the trains been equipped with a suitable system of brakes. The immense advantage of a brake like that of Westinghouse is now so well recognized that no argument in its favor is needed. There are hundreds of cases where the whole safety of a train depends upon whether it can be stopped within five hundred or one thousand feet. It seems almost incredible that a heavy railroad train running at a rate of fifty miles an hour can be stopped in fifteen seconds, and in a distance of less than seven hundred feet; but it can be done, and if it had been done, by far the larger part of the worst catastrophes we have had during the past twenty years would have been prevented. The next best thing to stopping the train before a collision or a derailment takes place, is to make the cars in such a manner as to resist the tendency to crushing. The railroad train of twenty years ago was a loosely connected collection of badly made carriages, admirably designed to double up and slide over one another, and crush the passengers by the operation known as "telescoping." The train of to-day consists of a firmly made line of well-built carriages, so connected that telescoping is almost impossible, and able, if occasion demands, to resist very considerable shocks. The old train was a series of blocks of various shapes and sizes, arranged in a somewhat crooked line, and utterly unable to resist any great amount of compression without doubling up. The new train is like a straight and continuous, but somewhat elastic beam, which requires great force to destroy it. It is not too much to say that the Westinghouse brake and the Miller platform and coupling together would certainly have prevented three-fourths of all the injuries from collisions that have occurred in this country for the last twenty years.

Looking at the second of our tables above, we find that accidents from defective roadway and defective machinery make full as bad a showing during the past few years as those from collisions. Indeed, there has been a regular increase since 1878, the number of accidents, the number killed, and the number injured

having doubled since that time—a result by no means referable to the increased length of road or the increased amount of traffic. An examination of the accidents from broken rails, of which five hundred and fifty-nine have been recorded during the past nine years, shows that these occur much oftener in cold than in warm weather, and more frequently in severe than in mild winters; the accidents for January, February, and March during the above time numbering three hundred and thirty-three, while the number for July, August, and September for the same years was only fifty-two. Rails break in cold weather from various causes. In badly ballasted and badly drained road-beds the track is much more unyielding in winter, and the shocks upon the rails much greater. It is also well known that iron containing any considerable amount of phosphorus is very liable to break under a sudden shock when the weather is cold. Rails made of good iron do not break in winter, no matter how severe the cold. In Scandinavia, with a climate more severe than that of America, accidents do not occur from broken rails, simply because in that country none but the best iron is laid upon the railroads. Good iron laid upon a well-drained and well-ballasted road-bed will save nearly, if not quite, all of the disasters from broken rails.

We come now to a class of accidents which are, perhaps, more fatal than any others—the breaking-down of bridges. In these catastrophes all horrors combine—crushing, mangling, drowning, and burning, and here again our record is not at all encouraging, the number of bridge disasters in the United States for the past nine years having been as follows:

1873	1874	1875	1876	1877	1878	1879	1880	1881
19	33	26	20	21	21	17	16	43

If we left out the first and the last of the above numbers we might flatter ourselves that a gradual improvement was taking place; but what are we to say of the forty-three disasters in 1881, which seems to be the worst year we have ever had, and this in spite of the fact that we have been all the time improving our knowledge and our practice of bridge-building, and that we certainly know more about such work now than we ever did before.

Railroad bridges, whether of wood or iron, can be so made as to be entirely safe under all ordinary conditions of service, and they can be kept under such inspection that no element of

danger shall be allowed to develop itself. While, however, our larger roads, as a general thing, buy good bridges and keep them under rigid inspection, many of the smaller roads buy very poor bridges and keep them under no inspection at all; for the examination of an iron bridge by the ordinary road-master, or the walking over these structures by railroad commissioners once a year, can hardly be regarded as inspection. The Ashtabula bridge, which broke down in 1876 upon the Lake Shore Railroad, killing over eighty persons, fell, it is stated by the legislative committee appointed to investigate that disaster, "under an ordinary load, by reason of defects in its original construction, which defects would have been discovered at any time after its erection by careful examination"; and the report adds: "The bridge was liable to go down at any time during the past ten or eleven years, under the loads that might at any time be brought upon it in the ordinary course of the company's business, and it is most remarkable that it did not sooner occur." Half an hour of competent and honest inspection would have condemned the Ashtabula bridge upon the day it was finished.

The Tariffville bridge—which fell in Connecticut in 1878, killing thirteen persons and wounding thirty-three more—is not an unfair specimen of a large class of wooden bridges in use to-day upon American railroads. In point of design, proportions, dimensions, and reputation of its builders, it was fully up to the average of such structures. It had been periodically inspected and pronounced all right. While no competent expert would ever have pronounced it a first-class bridge, no person could say from looking at it that it was not able to carry the ordinary railroad train safely; but when the right combination of circumstances came it fell, and exposed the hidden defects that caused the disaster. Though nominally a wooden bridge, like all such structures, it relied entirely upon iron rods to keep the wood-work together. These rods, it is reported, when tested, broke with a single blow of a hammer, very much in the manner of cast iron, and showed a very inferior quality of material. This was a defect which no ordinary inspection would detect, and one which may exist to-day in hundreds of bridges now in use upon our roads. We have in this country no system of control or inspection which can prevent the building and the use of exactly such bridges as that at Tariffville.

It may be asked if any railroad company—being, of course, aware of its liability for damages—will knowingly allow a defective structure to be made or used upon its road. It is perhaps hardly fair to say that such things are done knowingly, but they are certainly done heedlessly, and the result is the same. Not less than half of the wooden bridges made upon our railroads—and on many of our best roads, too,—are built by mere carpenters, who can do just one thing—perpetuate the blunders they have been brought up to. Not one-half our wooden bridges have ever been subjected to any computations whatever, but have been proportioned by a kind of guess-work; based upon a greater or less degree of experience, it is true, but experience of a very unsystematic kind. Add to this that nearly all of our older bridges were designed for trains and engines much lighter than those in present use; that there are many disreputable concerns which build very poor and unsafe iron bridges, and railway directors willing to buy such things because they are cheap; and, finally, that we have no efficient system of inspection, and we need not wonder that twenty-four bridges, on an average, break down every year. At the same time, we must bear in mind that there is no need for this class of catastrophes; that any company can at any time buy a bridge of a first-class concern, which shall be guaranteed absolutely safe and permanent by the very best authority.

We can have as much safety as we choose to pay for. As a general thing, the managers of our larger roads are well aware that they cannot afford to run any very great risks; they are intelligent, they are progressive, they are liberal; and we need no better evidence of the skill and care with which railway traffic, on the whole, is carried on, than the fact that not one passenger in a million is killed in this country by any cause for which the companies can be held to blame.

Except in one or two States, we have no system of public inspection which has ever been able to detect the weak points in a railroad, or to prevent disasters; and, considering the form of our government, it is quite doubtful if we ever shall have. The way, however, to all desired improvement is very plain, if the public and the companies care enough about safety to exert themselves to get it. We have already seen that the public is itself accountable for by far the larger part of the injuries, and to that extent it must mainly rely upon itself for

increased safety. A careful examination of the various causes of railroad accidents shows that three-fourths of all injuries to individuals may be avoided by obeying the following very simple rules. *First.* Never walk upon a railroad track or bridge. *Second.* Never cross a railroad without looking in both directions for a train. *Third.* Never get on or off the cars, nor pass from one car to another, nor stand upon the platform when the train is in motion, no matter how slow that motion may be. Be especially careful to regard the above rules when in or about railroad stations, and remember that the disaster, when it occurs, always comes in an unexpected form, and at an unexpected time.

Of the remaining one-fourth part of all accidents, the control of which is in the hands of the railroad companies, by far the larger part can certainly be avoided by means of the improved modes of construction, maintenance, and operation, which have been thoroughly tried and demonstrated to be good. Well-paid and competent employés, whose personal interest is thoroughly enlisted for the welfare of the road, a rigid system of personal accountability through every grade of service, intelligent use of the telegraph in train movement, well designed, thoroughly built and carefully inspected roadway, bridges, and rolling-stock, —these are the guarantees for exemption from railroad disasters.

GEORGE L. VOSE.